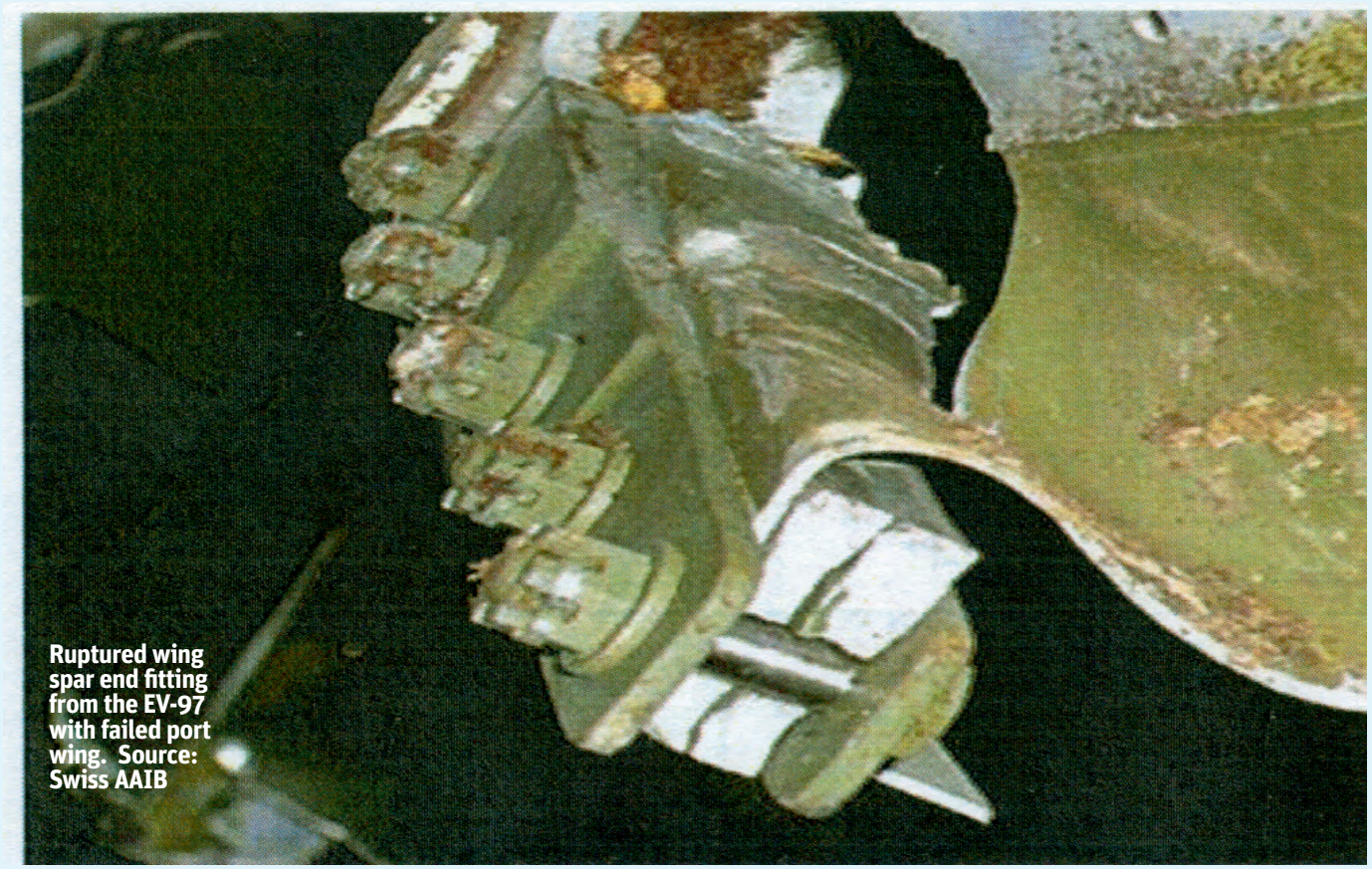
EV-97 Eurostar - Overseas wing failure



Ruptured wing spar end fitting from the EV-97 with failed port wing. Source: Swiss AAIB

HERE we both are again; you the reader, and me the writer, settling down for a brief excursion together into the world of aviation mishap. No chat conducted in the earliest hours of a new year should be without the usual formality so, a Happy New Year to you. I hope that what you have planned goes according to plan and the inevitable 'unplanned' events are all good ones. I guess that you'll sort things out whatever happens, if you don't who will?

If you are one of the fortunate few who own an aircraft then remember, every relationship needs a bit of work sometimes. She'll get very lonely, and probably a bit damp, sitting in that hangar day and night without company.

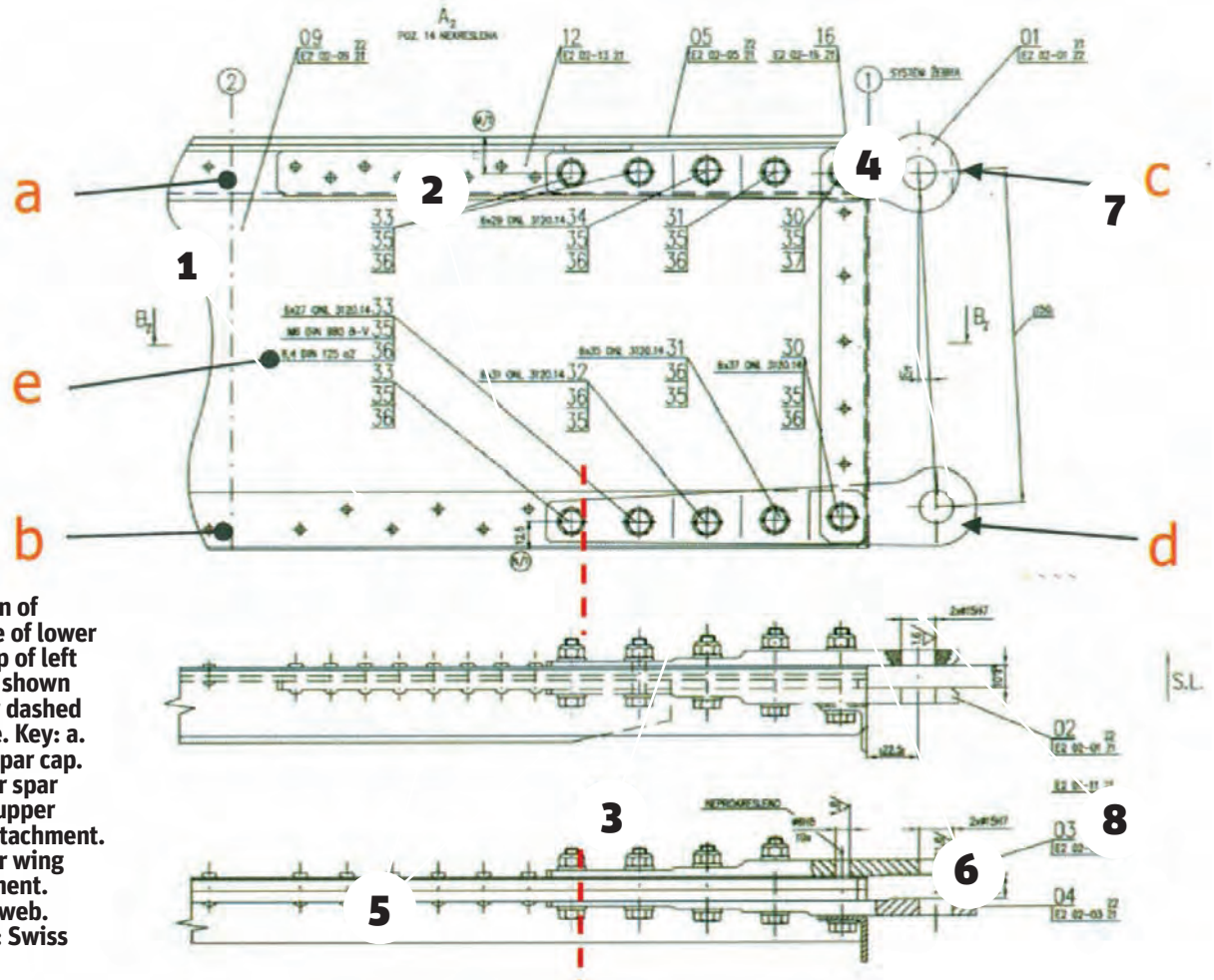
Believe me, I know what a pain it is to drag yourself away from the television, climb in the car, drive miles to the airfield, open up the hangar in the freezing rain, and drag all the other machines out the way... just to get to your beloved flying machine. She'll pay you back though if you make the effort, and she'll give you trouble if you don't.

'Aircraft flying in the UK will have the Never Exceed Speed and Manoeuvring speeds reduced'

Why not get on the 'phone and call up a couple of the other besotted aircraft owners who share your hangar and arrange to give your aircraft (and theirs) a joint cuddle. Run the engine, get it right up to temperature. Exercise the alternator; get it to push a few electrons around; batteries don't like sitting about for ages doing nothing. Switch on the radios, work the brakes; the weather may be rubbish, but there's no reason not to give your aircraft a workout. Just moving the thing shakes the molecules up in the tyres, and they'll feel better for it... and so will you!

2009 was an interesting year for Safety Spot, we covered a lot of stuff together and I thoroughly enjoyed the experience. I certainly learnt a lot from you. Thanks for sharing your experiences with me, after all, Safety Spot is only as good as the stuff you send me to put in it, so please keep sending your stories and comments. Constructive criticism is welcomed and, thanks to the powers of the internet, has been received from all over Europe, America, even Australia and New Zealand. The American's seem to like the honest, warts and all, approach; perhaps as a contrast, after all everything's 'just wonderful' over there.

So, closer to home, what shall we start the new year with? Well, the issues surrounding the Zenair CH 601XL seemed to have settled down somewhat and UK owners who have



Location of fracture of lower spar cap of left wing is shown here by dashed red line. Key: a. upper spar cap. b. lower spar cap. c. upper wing attachment. d. lower wing attachment. e. spar web. Source: Swiss AAIB

incorporated the mandatory changes required to meet compliance with CS-VLA are back in the air, thank goodness. The 601 is still a fantastic little aircraft, it was before all the fuss that surrounded it through last year, and it still is. It must be remembered though, by all, that this is a kit built aircraft operating on a Permit to Fly. It's not got, nor could it probably ever get, a Certificate of Airworthiness.

A Certificate of Airworthiness is not just about the initial Design Certification, it's a whole life thing. Firstly, during the design process, the requirements are far tougher. Secondly, the manufacturing company will need to be approved by an Authority. Thirdly, every item that goes into the aircraft needs to come from an approved source and that the complete history of that item must be recallable. This is called 'complete traceability' in the trade, and it is extremely difficult to manage. Permit aircraft do not require any of this 'bookkeeping'.

You may wonder, as I often do, why many of the engines and aircraft being introduced into this (fairly new) market are so expensive, indeed, comparable with fully certified machines, especially since manufacturing costs have plummeted over the last few years. For example, not so long ago it would have been virtually impossible to pre-drill the rivet holes in aircraft skins with any (trustworthy) accuracy, now it's the norm.

I should say here, as an out an out LAA'er, that I get concerned when I see advertisements and features in other aviation glossies shouting from the rooftops about this 'new age of the kitplane'. A kitplane is just that, a kit which an LAA member turns into an aircraft. It will never be a series production aircraft, no two will be exactly the same and, in my opinion, thank goodness. A company that sets itself up to assemble and subsequently sell aircraft from kits must, in the UK at least, be an A1 approved manufacturer of aircraft.

Perhaps market economics are demonstrating that the reason for the high costs involved in aircraft production actually have less to do with 'overbearing regulation' and more to do with the small production runs associated with aircraft, giving lie to the need for massive shake up within the certification environment for sports aircraft demanded by (almost universally, foreign) manufacturers. The UK authorities have always demanded the highest possible standard for series production aircraft, each certification requirement has been written in somebody's blood. 'We see further because we stand on the shoulders of those who go before'. Take heed... tinker at your peril, the structure has evolved and, as such, is very complicated. Imagine what a duck would look like if you tried to redesign it for some spurious reason... it doesn't bear thinking about; in complex legislation each full stop could become an essay.

This 'whole of life' thing extends into every part of the aircraft's operation, from the requirement to fit Certified parts, to the licensing of the individuals who fit the parts.

A Permit to Fly aircraft is allowed to be operated during the day in nice weather by amateurs; this status, incidentally, has nothing to do with skill level whatsoever. Let's be careful that we don't inadvertently lose this privilege.

The LAA has recently been faced with a problem that has beset one aircraft type within its varied fleet, this concerns the third area of difference between uncertified and certified types discussed above, that of sourcing and policing materials.

JUNGLE DRUMS

I like to think that the Airworthiness Department within the LAA does a good job in keeping members informed about what's going on within our fleet on a very limited budget. I'm long in the tooth enough to know that much of what goes on out there 'in the field', I won't hear about, but I trust the system and have learnt to read the Jungle Drums. Generally, if something happens to an aircraft on the LAA fleet other owners, with similar types, will get to know about it, often through the efforts of the LAA Airworthiness Department.

This is another area of difference between the certified and uncertified world, the manufacturers or their agents have no responsibility for continuing

airworthiness post sale. Recent flip-flopping of the ownership of some quite major manufacturing companies demonstrates this potential lack of continuity. In the LAA we're trying hard to develop a system of back up for owners which we call 'Centres of Excellence'. This may or may not be the aircraft's agent; it may be that the agency may not have any engineering expertise so couldn't be accepted by us as a Centre of Excellence.

For most of the LAA's fleet of course there are no agents, the Pietenpol Air Camper is a good example of this as it is a plans built machine. In this case, a group of enthusiasts got together to form a Centre of Excellence and very competent one it is too. In the case of the Eurostar the Centre of Excellence is the agent, Cosmik Aviation. They're an A1 approved manufacturer of microlight aircraft and assemble kits from Evektor.

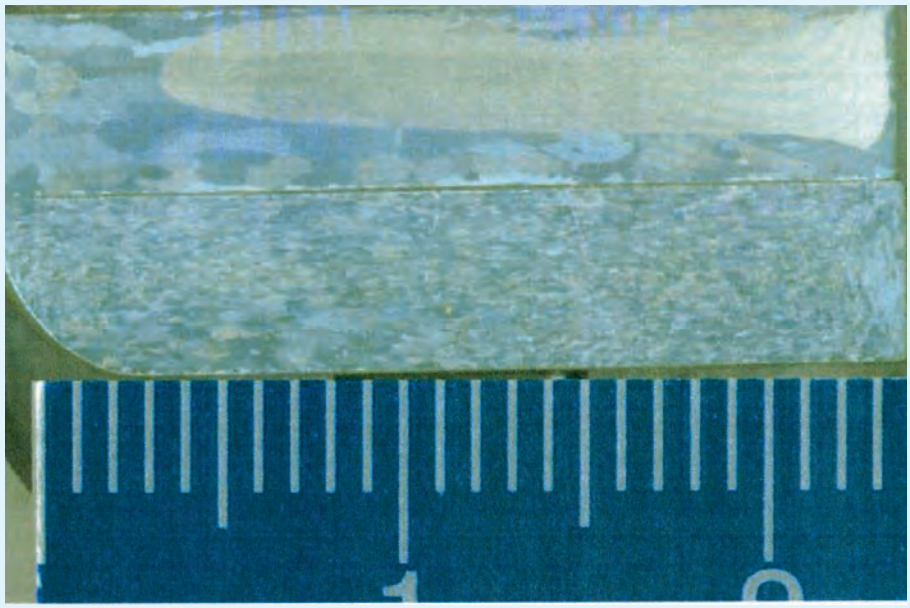
In the UK the maximum weight for a microlight it 450kg and the EV-97 Eurostar just creeps into this category. I remember the agent requesting us to authorise a small modification to the seat pan to protect the pilot's rump in the event of an undercarriage failure. The mod was simply a Kevlar panel under the cushion but, after weighing, it couldn't be fitted as the aircraft would have gone over weight - that's sailing close to a design limit, which has to be applauded.

Although the LAA is authorised to manage Series Production Microlight Aircraft in the UK, in this case the aircraft are looked after by our colleagues at the BMAA. I looked around, and was very impressed by the latest machine from the Evektor stable at Sywell recently, in the UK it carries the designator EV-97SL. There are three principle EV-97 models operating under LAA administered Permits to Fly. The first type is the 450kg kit-build microlight, the LAA designates this machine the EV-97, there's about 56 of these aircraft on our books. The fact that this aircraft is a microlight changes nothing as far as the certification process but, because this aircraft is not built by an A1 manufacturer, it cannot be used for commercial training.

The EV-97A is this aircraft's big brother, it's the Group A version and is certified to a maximum weight of 480kg - actually the only difference to the airframe is the addition of a fuel pump. We've got 17 of these aircraft operating under an LAA Permit to Fly. The latest machine from Evektor is classified by the LAA as the EV-97SL as I've already mentioned, there's only one of this type flying at the moment, the demonstrator, but the aircraft has now been cleared fully as an LAA type. The 97SL is essentially the same airframe as the other machines but there has been a reworking of the cockpit areas. Needless to say, I'm nothing like fleet-footed enough to get to fly it yet, so I cannot comment about what it flies like, you'll have to read FD's flight test in the October issue!

Interestingly, because the German Authorities mandate the use of parachutes in their microlight aircraft most European machines are certified at a weight above the microlight limit of 450kg. Hence the same airframe for 450kg and 480kg. machines. The Eurostar essentially operates within the interface between the Group A (OK, SEP) and microlight worlds. So, after this long introduction what's the problem with the Eurostar fleet?

The first sign of trouble with this type my desk saw was when one of my spotters sent me a link to a Swiss accident report closing an investigation to an accident that befell an EV-97 in June 2006. I asked about it here at the LAA and one or two of the engineers had heard of the double fatality, but understood that the incident occurred in the mountains and was weather related. The report made some sobering, and quite worrying reading. One of the first questions I had was why it had take over three years for the information to reach our shores, let alone my desk; I will be pursuing this but, at the time of writing nobody has an answer.



This is a picture of the lower spar cap of the left wing looking outwards (slightly magnified) showing considerable inhomogeneity within the materials matrix. Source: Swiss AAIB

'It appears the failure of the port mainplane is a fairly straightforward overload failure'

In short, the Danish registered microlight aircraft failed to return to its departure airfield after a sightseeing flight. A search was initiated and the wreckage was eventually found. The accident has been attributed by the Swiss AAIB to a failure of the port mainplane, and it appears that the failure is a fairly straightforward overload failure (if there is such a thing as a straightforward failure!). Subsequent investigations showed that the aircraft's Maximum Operation Empty Mass for this machine should not exceed 210kg. (The Danish regulations consider this to be the Maximum Operational Empty Mass for two-seat microlights) which is a figure that would be impossible to achieve for an EV-97, the aircraft had a placarded empty mass of 285kg.

Personally, I don't like this empty mass rule; it was put in place to avoid the need to teach microlight pilots about weight and balance and has always made little sense to me. Perhaps the authorities feel that the intellectual powers required to calculate the centre of gravity of an aeroplane are beyond those that fly microlights, notwithstanding that many microlight aircraft outperform their Group A cousins in almost all departments. The most important weight in an aircraft is, of course, the maximum take-off weight. In this case it was found to be 467kg, so the aircraft was a little overweight for the rules (max 450kg) but, as we have previously discussed, still well within the airframe's capabilities. This particular machine had done about 500 hours at the time of the accident.

Mountain flying can be hazardous and the report goes to some lengths to establish the weather at the time of the accident, but, whilst the weather was not brilliant, it was impossible to establish whether weather played a part. Certainly, apart from the obvious physical dangers of flying around mountains, particularly in low visibility, there are the added effects of mountain winds. Local mountain winds can be sudden and violent, often lasting only a few minutes. Could this have been the primary cause of the wing failure, I expect we shall never know? Interestingly, especially bearing in mind the recent arguments surrounding the UK IMC, the Swiss have a special mountain flying training scheme which I understand they intend to keep (quite rightly in my opinion).

Because the failure of the wing was easily identifiable it was possible to look closely at the construction and the materials used in the area of the failure and here is where things get interesting from an engineer's perspective. The testing of the constituents of the material used was AlCu4Mg1 and this relates to an aluminium alloy well understood by the aerospace industry, 2024. Nothing unusual about this. When this material was tested it was noticed that there was a huge spread of hardness values across the test pieces. This is unusual and, when the tensile strength was measured the test pieces were shown to be something over 25% down on expected values.

Although a material's properties are determined by its constituents in very large measure, the actual constituents are only part of the story, like baking a cake, there's more to it. As with baking that cake, one of the most important aspects that will change how a

material will behave is how the material was heat treated during and after production. Four aspects are important here, local environment (ie, the surrounding chemical environment), the temperature change profile, time, and maximum temperature. It is quite difficult to determine heat treatment protocol post failure, I asked a few of my chums who are more into this than me and they tell me that and there are two principle ways of doing this.

The first is testing, then re heat treatment and re testing, after a statistical analysis it is possible to elucidate the material's (probable) original heat treatment state. The second is to look inside the structure of the material, and this metallographic analysis is what was done by the Swiss AAIB. Actually, these tests were conducted on two airframes, the crashed machine itself, and another machine that had crashed previously for unrelated reasons.

It was found that the material exhibited some gross inhomogeneity at the microscopic level. There are a number of reasons why this may have occurred, some are mechanical, related directly to the extrusion process, and some may be directly connected to the heat treatment management process' during the manufacture of the originating billet or, possibly, post extrusion. Materials scientists are working to discover the full story behind this quality drop off. With regard to the mechanical problems that may have lead to the differences in grain structure the following may be relevant.

In a continuous extrusion process, when one billet runs out, another one is fed into the extrusion machine to replenish it, generally though, for low volume production, or when the final product lengths are relatively short, the extrusion process ends when the billet runs out. In the continuous process it is normal, during the billet changeover, for the material from the new billet to flow into and fuse with material from the old billet.

If you look at the microstructure at this point in the photograph from the Swiss report you can see a sort of intergrannular tongue, which may show the transitional effects of this fusion. It has to be said here that this statement carries a huge health warning and, just because it looks like some kind of fusion process, it may represent nothing of the sort.

One thing for sure though is that this kind of variation within the grain structure of the materials tested will affect the mechanical properties of a component which, as we have seen with other material problems over the years, must include its fatigue and corrosion properties. It would be normal practice to reject this transitional material, if that's what it is but in this case it looks like the mill producing the extrusion failed to do this and it slipped into the aircraft production chain. Naturally, investigations are taking place to establish the hows, whys and whats about this.

Clearly, now these problems have come to light, there will need to be some checking of Eurostar aircraft but, at the time of writing the Eurostar fleet has not been grounded. The reason for this decision, in our usually conservative world, is that the aircraft used to test the wing strength of the original machine during EV-97 certification tests was constructed with material similar to that used in the accident (and the other test) aircraft. The test wing not only survived the test loads but survived an overload of 17%.

Meetings and discussions involving the CAA, Evektor, Cosmik, the BMAA and, naturally, the LAA are ongoing but it has been decided that, in order to address the possibility that aircraft are flying in the UK with reduced strength structural components, the Never Exceed Speed (Vne) and Manoeuvring speeds (Va) will be reduced. This will have the effect of reducing the flight envelope positive g limit from 4.0g to 3.0g which will restore the normal safety margins.

Evektor and Cosmik are working flat out to design a Non Destructive Test method to identify sub standard materials, should there be any, in the EV-97 fleet. Initially a Mandatory Permit Directive (MPD) will be raised by the CAA effecting the Operating Limit changes. When an appropriate (and acceptable) inspection mechanism becomes available the MPD will be amended to accommodate this. All in all though, this is not a very good Christmas present for EV-97 owners.

Eurostar EV-97 SL tested by Light Aviation last October

LAA ENGINEERING SCALE OF CHARGES

LAA Project Registration	
Kit Built Aircraft	£300
Plans Built Aircraft	£50
Issue of a Permit to Test Fly	
Non-LAA approved design only	£40
Initial Permit issue	
Up to 390kg	£300
391 - 499kg	£405
500kg and above	£540
Three seats and above	£600
Permit renewal	
Up to 390kg	£100
391 - 499kg	£135
500kg and above	£180
Three seats and above	£200
Modification application	
Prototype modification	£45
Repeat modification	£22.50
Transfer	
(from CofA to Permit or CAA Permit to LAA Permit)	
Up to 499kg	£135
500 kg and above	£250
Three seats and above	£350
Four-seat aircraft	
Manufacturer's/agent's type acceptance fee	£2,000
Project registration royalty	£50
Category change	
Group A to microlight	£110
Microlight to Group A	£110
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